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ABSTRACT

Rural elementary school teachers interested in improving science instruction are frequently hampered by inadequate training in science, lack of information on local natural history resources, and time and curriculum constraints. On the other hand, rural schools are usually located near meadows, forests, or undeveloped land, and rural students usually have greater experience with nature than their urban counterparts. Since 1986 a collaboration among the New Mexico Center for Rural Education, the New Mexico Museum of Natural History, and rural elementary schools has explored promising ideas for improving elementary science education in rural schools. This collaboration, the New Mexico Rural Science Education Project, has (1) developed and tested a rural science teacher training model that utilizes the strengths of the collaborators; (2) provided rural elementary teachers with information and resources and assisted the teachers in developing activity kits and specimen collections; (3) planned and executed natural history field schools for rural elementary teachers and students to demonstrate hands-on outdoor science activities and model effective teaching methods; (4) planned and conducted an intensive week-long science education institute for rural teachers; and (5) established a statewide network of scientists, technicians, and naturalists willing to conduct science programs in rural schools on a volunteer basis. This report includes the results of project evaluations of first and second year activities and the Summer Elementary Science Teachers' Institute. (SV)

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IMPROVING SCIENCE EDUCATION IN RURAL ELEMENTARY SCHOOLS:

A NEW APPROACH

Presented at
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IMPROVING SCIENCE EDUCATION IN RURAL ELEMENTARY SCHOOLS:

A NEW APPROACH

A cooperative effort between New Mexico rural elementary teachers, the New Mexico Museum of Natural History and New Mexico Center for Rural Education at New Mexico State University has established promising ideas for improving science education in rural schools. The approach outlined here recognizes the needs of rural elementary school teachers as well as the strengths of rural schools. The New Mexico Rural Science Education Project also draws upon the strengths of state Natural History Museums and university-based Centers for Rural Education in order to improve science education in rural elementary schools.

Needs of Rural Elementary School Teachers. Rural elementary school teachers frequently have broad but superficial training in science. Teacher candidates take general science courses which provide an overview of the subject matter with little depth. College level general science courses are test-oriented courses taught to large groups of students in lecture format. The texts used are generic in nature, written to be applicable to students in colleges and universities across the United States. Laboratories, when offered, use planned indoor activities requiring equipment not often affordable outside the college laboratory. Science pedagogy courses are designed to develop teaching methods but do not provide additional depth in the subject matter. Upon reaching the rural elementary classroom, worlds away from their college campuses, many teachers feel inadequately prepared to teach science, let alone to depart from a textbook and develop science activities using local resources.

Teachers in rural elementary schools who are curious about their local flora, fauna, or geology and wish to use natural resources near their school, soon find that there are no reference books or educational materials developed which pertain specifically to their local environment. Excellent generic environmental education materials may be available to them but even these do not capitalize upon the abundant opportunities available locally. Sometimes a parent or other area resident is knowledgeable about one or more aspects of the natural history of the area and can provide assistance to teachers. However, teachers may be inadequately trained to translate this information

into activities which will guide students to discover more about the natural history of the area.

Information on natural history, botany, geology, zoology, etc. pertaining specifically to local environments often exists in abundance in the professional literature of various science disciplines. This, however, is outside the normal reading material of rural elementary school teachers. Unless the teacher has a personal subscription, the material is not readily available to them. Also, the information for any given local area is so scattered through many subject-specific journals and over many volumes depending on when the reported study was completed. Articles are usually research oriented, written in scientific jargon, and meaningful only to others with expertise in the field. Research activities are beyond the reach of the elementary classroom, requiring skills and equipment that are not available.

Rural elementary teachers teach reading, spelling, grammar, mathematics, and social studies and may teach art, music, or physical education along with other subjects. They may have playground or lunchroom duty, sponsor clubs and activities or coach extracurricular sports, to say nothing of family and community commitments, all of which require their time. Teachers do not have spare time to develop science activities which utilize local natural resources, nor do they possess the libraries necessary to research needed background information from the technical literature.

Teachers also work under mandated goals and objectives from their state's Department of Education and their local curriculum committees. Activities must be designed to teach content and skills which meet established goals and objectives. A commercially produced teacher's guide which accompanies the science text and materials used in the classroom provides the teacher with "canned activities designed to teach specific skills. Textbook companies may even have state representatives who will give free in-service workshops to help teachers effectively use the text and materials to meet state and local goals and objectives.

An inadequate background in science, lack of available information about local natural history resources, time constraints, and state and locally mandated goals and objectives, combined with a readily available generic text and materials, make it easier to follow the path of least resistance. Teachers teach as they were taught, using generic texts and materials which are as applicable in New York City as in Magdalena, New Mexico.

Strengths of Rural Schools. Rural schools are usually adjacent to or within walking distance of open areas of land which are rich in natural resources. Forests, riparian areas, grasslands, and other undeveloped land areas near rural schools contain the "stuff of elementary science." Insects, mammals, birds, wildflowers, grasses, trees, rocks, fossils, geologic formations, and many other natural resources can be used in the teaching of science. The open areas provide outdoor classrooms with an abundance of scientific specimens which are not readily available to the urban and suburban schools. The fact that these specimens are representative of the local natural history, and not simply purchased from a science supply catalog, makes them all the more effective in bringing science to the students. On another level, the smaller rural schools have fewer administrators, a shorter chain of command and thus more flexibility in the schedule, making it easier for teachers to plan excursions into the outdoor classroom.

Rural school students typically have greater experience with nature than their urban counterparts. In rural areas, children grow up surrounded by open and natural areas where they play and explore, developing an implicit, experiential knowledge of the natural world. Rural parents are more likely to be

ranchers, farmers, hunters, trappers, or fishermen, and to have gardens than parents in urban or suburban areas. Working with their parents, children begin to develop theories and opinions about the world around them. At the same time, elementary aged children are open to the excitement and joy of science. These students are ready to have science introduced in a way that combines their developing interest in their own environment with methods of exploring that world.

Strengths of Natural History Museums. Museum curators are scientists with expertise in specific areas of natural history. They are also collectors of specimens, concrete objects that embody and exemplify the abstract principles of science. These scientists possess knowledge of their subject, especially as it pertains to local natural history. Museums also have education departments whose day-to-day task is to captivate and educate paying customers who choose to visit the museum. Given this challenge, museum educators develop techniques that are entertaining, educational, and focus on concrete museum specimens. These techniques have much to offer to elementary teachers.

Strengths of Centers for Rural Education. Centers for Rural Education have staff members who have expertise in education and have conducted research in the area of rural education. They have also been involved in training teachers and administrators for rural schools. Because of their work with rural schools within their state, the staff members are familiar with the needs and concerns of rural teachers, especially as the teachers are affected by the local culture, economy, and distance from major centers of higher learning. As educators, in constant communication with state education officials, they are aware of the state-mandated goals and objectives and can provide pedagogical expertise in developing activities to meet these goals and objectives. The staff of the Center for Rural Education provides the bridge between the Natural History Museum and the rural school teachers.

The New Mexico Rural Science Education Project. In response to the perceived needs for support and improvement in rural elementary science classes, the New Mexico Rural Science Education Project (NMRSEP) was formed in 1986 and funded by the National Science Foundation. The general purpose of the NMRSEP is to help improve science education in rural elementary schools and to do so in a way that could be replicated in other states with largely rural populations. In particular, teachers were provided with specific background information and the support they needed to use local natural resources to teach science to children.

Recognizing the needs of rural elementary school teachers and using the strengths of rural schools, the New Mexico Museum of Natural History, and the New Mexico State University Center for Rural Education, NMRSEP has experimented with teacher workshops, teacher-developed natural history activity kits focusing on local materials and themes, natural history field schools, and individualized support services to meet the needs of rural elementary school teachers. The research covered two years with the teacher workshops and development of kits taking place in the first year and the Natural History Field Schools and individualized support services taking place the second year.

NMRSEP is now in its third year and is currently funded with a grant from the New Mexico Commission on Higher Education. At the beginning of the third year, NMRSEP held a Summer Elementary Science Teachers' Institute which immersed participating teachers in a week-long natural history/science education workshop.

Five rural schools in New Mexico participated in the initial two year phase of NMRSEP: Hatch, Magdalena, Estancia, Cuba, and Dulce. A brief profile of each school is presented in Table 1.

Table 1

Profile of School Districts Participating in New Mexico Rural Science Education Project

School District:		Cuba	Dulce	Estancia	Hatch	Magdalena
Number of Students enrolled grades 1-6		196	259	322	492	151
Ethnic Diversity of Students:	Anglo	9.7%	0.6	46.5	22.6	20.9
	Hispanic	34.9	9.3	52.8	77.4	35.5
	Native American	55.4	90.1	-	-	43.6
Teachers:	Anglo	31.6	37.8	75.6	71.6	64.3
	Hispanic	57.9	54.1	11.1	28.4	35.7
	Native American	10.5	5.4	-	-	-

Information from: New Mexico School District Profile 1986-1987 School Year

Methods

Teacher Workshops and Activity Kits. Project staff developed sample kits to be used as models by the participating elementary teachers. Day-long workshops were scheduled with participating teachers at each of the five schools. During the workshops, project personnel introduced the project, presented information about local natural history, and exhibited sample kits based upon local environments. A workshop was conducted by a project staff member from the Center for Rural Education on teaching strategies and curriculum development. Staff members also gave seminars on how to develop a science kit using local natural resources and on expected outcomes of the project.

A resource inventory of each participating school's community was conducted, starting with the area near the school. Teachers participated in these surveys that documented the natural history of the area, the materials available and their potential for teaching science to children. Bird and mammal sightings and tracks, the occurrence of plants, and geologic setting were noted and presented to the teachers as the raw materials for kits. At the end of the workshops, regular meetings were scheduled with the teachers during which teachers and project staff reviewed the progress of the kits. Typically, project staff left these meetings with assignments from teachers to collect information on some relevant topic. In this way, project staff and participating teachers functioned as curriculum development teams.

Teachers were expected to develop kits over a period of approximately one year. During this time, field trips to local sites were conducted for teachers led by experts in specific areas of natural history. While one teacher might request a specific field trip pertaining to the development of his or

her kit, typically many of their colleagues, families and students participated as well. In addition a special summer field trip program lasting one to two full days was offered during the summer of 1987.

Teachers were given "Using Local Natural Resources in Science Teaching," a booklet developed by project staff to assist them in planning their own kits. A workshop on science process skills was also offered to teachers in each district to help them in developing their kits. Kits contain background material on the subject, a set of classroom activities based on some aspect of the local natural history, and resources for students wishing to learn more about the specific topic.

Project personnel provided resource materials as requested by teachers. Videotapes, books, articles, and other information were gathered by staff members to assist teachers in the development of the kits. Staff helped with the identification of specimens collected for the kits. They also provided extensive editing services for the teachers, including having the material typed.

Natural History Field Schools. By the end of the first year it was apparent that continuing to prod teachers into producing natural science kits would be non-productive. While teachers continued to be enthusiastic about the natural science workshops, demonstrations, and field trips conducted by project staff, they clearly did not have the time nor the research skills necessary to create science kits and develop activities, even with support of the project staff.

On three separate instances, teachers expressed feelings of guilt and having "let down" project staff in not completing kits. what was needed was a means of instructing teachers about local natural history and science teaching methods in the way that we would like them to teach their students. The program also had to take less time on the part of teachers.

At the beginning of the second year, project staff systematically developed plans for natural history field schools, outdoor natural science events that were both educational and entertaining and that focused on the local environment. The natural history field schools also provided a means of instructing teachers about local natural history and science teaching methods. For each school a nearby site was chosen for the field school locations, typically a National Forest or tribal campground. Project staff arrived at the site the day before the field school was to be held, surveyed the natural history of the area, set out live traps for small mammals, and collected specimens for use in the next day's activities.

Typically, all students at a rural elementary school attended the field school for one of the two days that it was in session. Older students (fourth, fifth, and sixth graders) participated on one day and younger students on the other. As students arrived at the field school, they were greeted by banners and balloons and welcomed by project staff. Students were divided into groups of approximately 15 and given colorful identification buttons with local natural history images on them.

Groups of students rotated from activity station to activity station on a time schedule that gave older students 25-30 minutes for an activity and younger students, 20 minutes. Teachers were divided among the groups so that they could also participate in the activities. Parents were invited to attend and helped monitor student behavior so that teachers could be active participants in field school. Each group participated in six or seven activities depending on time constraints of the day. Activity topics included plants, mammals, insects, geology, birds, pond life, weather, fossils, owls, nature, sketching, and trees. Not all activity stations were available at each field

school. Rather, each field school was designed to take advantage of the particular natural resources of each community and field school site.

After field schools, packets of information and suggested follow-up activities were sent to teachers for their information and for use in the classroom. Project staff collected questions that were asked during the course of the field school and sent answers and a bibliography of suggested readings to teachers. Project staff also conducted follow-up meetings with the teachers to encourage and motivate them to use these activities and to work with the teachers to incorporate the activities within the established science curriculum for the school.

Summer Elementary Science Teachers' Institute. At the beginning of the third year, NMRSEP responded to teachers' requests for more in-depth instruction in natural science field activities by staging our most ambitious workshop to date, called the "Summer Elementary Science Teachers' Institute" (SESTI). SESTI was a five day residential workshop offered to teachers that were selected from each of 15 rural school districts that had chosen to participate in the NMRSEP during the 1988-89 school year. In addition to project staff from the New Mexico Museum of Natural History and the New Mexico State University Center for Rural Education, SESTI attracted many voluntary faculty from the museum, the University of New Mexico, the USDA Soil Conservation Service, the New Mexico Department of Game and Fish, and the USDA Forest Service. All guest instructors participated at no cost to the project and with permission of their employers

At SESTI, teachers and staff participated in a wide variety of science activities and explored the natural resources and fossil-rich badlands areas in the Nacimiento Mountains just east of Cuba, New Mexico. Through these activities, teachers gained extensive hands-on experience in natural science field studies. It was an opportunity for project staff to offer rural elementary teachers the best of the ideas, activities, and information developed over the course of the past two years.

Each activity at SESTI focused on the immediate environment of the Circle A Guest Ranch where the institute was headquartered. However, skills and activities learned during the week were transferable to each of the participating school districts. Teachers from each district met periodically during the week in order to adapt activities and approaches to their home environments and resources.

After SESTI, teachers were given an environmental survey form to complete, which identified local natural resources and opportunities for activities and/or needs for adapting existing ones. Over the course of the 1988-89 school year, project staff will visit each of the schools represented at SESTI and conduct natural science workshops focusing on the local environment. Project staff will be assisted in these workshops by local teachers who participated in SESTI.

Results

Evaluation of First Year Activities. A modified transactional evaluation model was used to evaluate the first year of the project. Teachers at two schools were interviewed, eliciting comments about development of kits, work with project staff, and participation in natural history field trips. A questionnaire was then developed from comments made in these two schools. Respondents are asked to agree or disagree with statements on a 1-4 Likert type scale with "1" being strongly agree and "4" being strongly disagree. The instrument has been used with teachers in two other schools. Table 2 presents

the statements concerning first year activities with which responding schools agreed as indicated by a mean response of less than 2.0.

Table 2

Responses of Elementary Teachers Participating in NMRSEP

Statement	Average Response
I enjoyed doing the research on my kit.	1.3
The support from Rural Science Education and Museum people was very good.	1.0
I would have liked a detailed outline of what was needed for putting together a kit.	1.5
I really enjoyed the trips the teachers took out in the field.	1.0
This project is helping me get an idea of what to do when I take my students outside.	1.4
I feel that working on the kits was very worthwhile	1.3
I am more enthusiastic about science since being in this project.	1.6

Teachers were very receptive to the overall project. They enjoyed learning about their local natural history and enjoyed working with project personnel. Some teachers reported that they had enjoyed the research they did in developing the kits. All teachers involved stated that doing the kits was worthwhile. Most expressed interest in seeing the kits which were developed at other schools. From the point of the view of the project staff, however, having teachers develop natural history kits was not viewed as a successful strategy for producing coherent, well-organized materials that could be shared between teachers within a district (i.e. according to plan.) However, during the second year, project staff discovered many positive outcomes of the teachers' science kits development project:

1. Many of the participating teachers (60%) were still collecting background materials for their kits as well as natural history specimens.
2. They were teaching science units to their students and using what they had developed.
3. Teachers indicated that they had learned a great deal from having worked on their kits and were very enthusiastic about them.

The natural history field trips were the most enjoyable to teachers. Project personnel and teachers spent the day immersing themselves in the local environment and its natural history. Following these experiences, teachers stated that they were now more aware of their local environment and the opportunities it offered for teaching and learning about science.

Evaluation of Second Year Activities. Teachers and parents were asked to assist with the evaluation of the field schools by responding to several questions. Comments were also invited. Each participating adult was given an evaluation card as he or she began an activity and the card from the previous activity was collected at that time. Response rate approached 100%. Non-responses occurred only when the teacher or parent hat to leave the station to

discipline a student or to escort younger ones to restrooms, neither of which happened frequently.

Table 3 indicates the percentage of responses to each question from three of the five field schools. Since there were no significant differences in responses from the individual field schools, data from the field schools have been combined.

Table 3

Evaluation of Field Schools

Statement	Percent Responding:			
	Yes	No	No Response	N/A*
Students learned to observe the natural environment	92.8%	3.0%	4.8%	-
Students learned how to properly collect a science specimen	76.4%	10.9%	10.9%	5.5%
Students learned how to work as a group	82.9%	9.1%	7.3%	3.0%
Students learned to protect the natural environment	55.5%	15.9%	25.0%	3.7%
Students learned that science can be fun	98.2%	0.6%	1.2%	-
Will you as a teacher or parent try to discuss activities presented at this station in your class or home?	89.6%	0.6%	9.8%	-
Was the amount of time allowed at this station too long?	5.6%			
about right?	67.7%			
too short?	26.7%			
Considering your group, was material presented at this station too complicated?	6.9%			
about right?	91.9%			
too simple?	1.3%			
Would you like handouts and other materials on this topic to use?	92.9%	0.9%	6.3%	

*Some respondents wrote that this was not applicable.

Teachers and parents were very complimentary about the field schools, stating that they had learned new things along with the students and that they had really enjoyed the day. The enthusiasm of parents was very important. Many times project personnel could not distinguish between teachers and parents. Sometimes the parents were more involved and enthusiastic than teachers. Since parental involvement with schools plays a role in improving the schools, field schools might be used at some later date for the purpose of increasing parental involvement in school. Parents frequently requested information from project staff after field schools and also requested that they be invited to attend future sessions. In several cases teachers discovered parents who were knowledgeable about certain aspects of natural history.

A variety of suggestions were offered for improving the field school. All comments were constructive, offering the project personnel information on ways to make the field schools better. Many useful suggestions from field school participants were put into effect in later field schools.

Students were interviewed informally throughout the day during breaks and at lunch time. Most enjoyed the field school. Some wanted more time at stations in which they had the most interest. Discipline problems were minimal indicating that students were participating in each station according to instructions given by the person in charge of the station. A few students expanded on an activity they had seen at the field school for science fair projects later in the year.

Evaluation of Summer Elementary Science Teachers' Institute. Participating teachers were given a science subject matter pre- and post-test that had been developed by SESTI instructors based upon the course syllabus. They were also queried on a number of other topics relating to the selection of topics for SESTI, the enjoyment of activities, the relative usefulness of the sessions to teachers, and suggestions for improvements for next year's program. Teachers were also given a science attitude survey at the beginning of SESTI which will be repeated after on-site visits are completed.

Graph 1 illustrates the gains made between pre- and post-test scores. As can be seen from the graph, teachers familiarity with the subject matter varied greatly when they arrived at SESTI. However, all teachers improved their scores significantly over the course of the week.

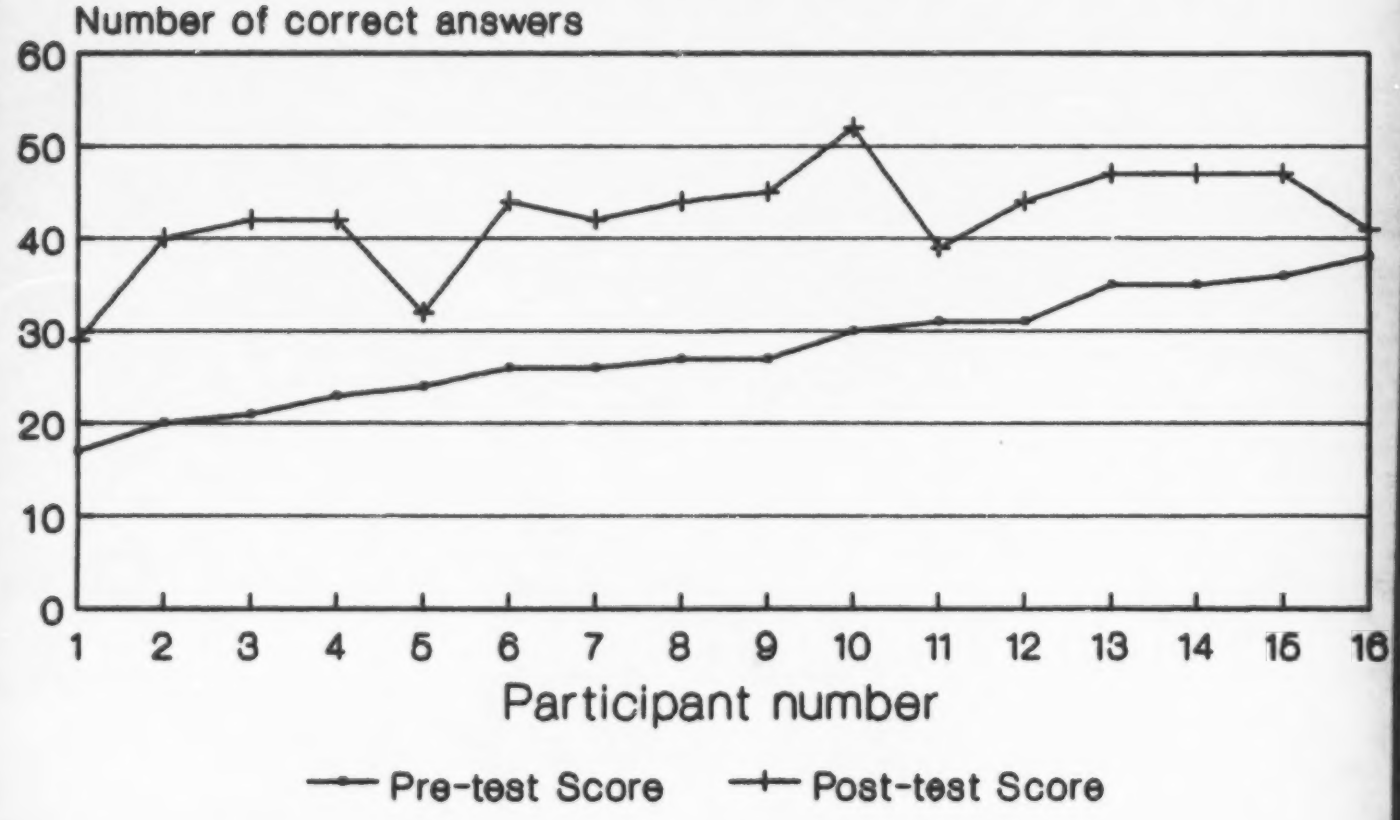
Equally as important as learning subject matter, teachers' responses to evaluations and their open-ended comments were enthusiastically positive about the science activities and SESTI, in general. This enthusiasm hopefully will carry over to the classroom and will be translated into more and better science education for students.

Summary of Accomplishments: Under National Science Foundation sponsorship, the New Mexico Museum of Natural History and the New Mexico Center for Rural Education at New Mexico State University joined forces to create a team consisting of rural educators, science educators, naturalists, scientists, and curriculum developers. Since 1986 this collaboration, called the New Mexico Rural Science Education Project, has:

1. Developed and tested an educational model for training rural teachers to teach science that utilizes the strengths of rural schools, university centers of rural education, and museums of natural history.
2. Worked with rural elementary teachers by providing information and resources and assisted the teachers to develop activity kits and collections of specimens for use in their schools.
3. Planned and executed natural history field schools for rural elementary schools that demonstrated hands-on science activities and modeled effective teaching methods.
4. Planned and conducted the first annual "Summer Elementary Science Teachers' Institute," an intensive week-long science education retreat for rural teachers. 5. Established a state-wide network of scientists, technicians, and naturalists who are willing to conduct science programs in rural schools on a volunteer basis.

The New Mexico Rural Science Education Project is continuing this project in order to reach all of the rural school districts in the state.

SESTI
Participant Scores



Maximum possible score = 58